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THE TEA QUARTERLY

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EDITORIAL

THE CONTROL OF PESTS, DISEASES AND WEEDS

In the June number of the *Tea Quarterly* we reproduced an address by Sir John Russell on the "Wastage of World Food Supplies through Diseases and Pests". Although this address was intended for a technical audience, it is so well written that anyone interested in the subject will gain from it a broad appreciation of modern advances in this branch of science. We particularly draw the attention of Ceylon tea planters to this article because of the sense of balance or perspective which it gives to the general subject of the control of pests, diseases and weeds.

Some planters may feel confused by the apparent wealth of new chemicals available for the protection of crops, and feel disappointed that they have not been applied to the control of pests and weeds in tea. The number of fundamentally new chemicals which have become available in the past few years for plant protection purposes is actually far more limited than the enormous number of proprietary formulations suggests. The Tea Research Institute is in close touch with fundamental developments and will continue to investigate all possible applications to the Ceylon tea industry.

Meanwhile, we strongly advise estates to wait for our precise recommendations, and draw attention to page 39 of the present volume of the *Tea Quarterly*, in which Sir John Russell quotes a passage from an address at the 1950 meeting of the British Association for the Advancement of Science.

> "[Dr. V. B. Wigglesworth] emphasised the need for fuller study of the effects of insecticides on the whole insect population, and for developing biological methods of maintaining a proper balance in the insect population. Chemical methods alone in his view will not suffice : 'the problem of pests in general', he says, 'gets worse.....new machinery and new chemicals are developed and we are carried from crisis to crisis always hoping that the newest chemical or the newest technique will provide the final answer.'"

We also warn estates that many of the weed-killers now widely advertised are based on chemicals which were developed for their selective action in the control of weeds in grass and cereal crops. These chemicals are highly toxic to tea and although much attention is now being given to selective action on the weeds of crops other than cereals and grasses, none of the chemicals so far developed will control the weeds in tea without risk of poisoning the tea bushes as well. The poisonous effects of weed killers are often slow to appear, insidious in nature, and require very careful investigation.

Apart from all the purely agricultural aspects of chemical control there are other important considerations concerning hazards to the health of labourers employed in applying chemicals, and all possible hazards to the health of consumers which have to be taken into account.

A few years ago a planter wrote to the Tea Research Institute for a piece of advice and said he required a straight answer to his question as he had found " experts " inclined to be evasive. In this case we will give a piece of advice on chemical control of diseases, pests and weeds without evasion, equivocation, or any form of reservation and it is simply to wait until the Tea Research Institute publishes specific recommendations.

As in the case of any other branch of our activities, arrangements can be made at any time to send a member of the staff to give a lecture or to answer questions on this subject at any local meeting of tea planters interested in more detailed explanations.

A SURVEY OF SOME LOW-COUNTRY PROBLEMS*

T. E. Walter.

In this paper which is based on an address given to the Morawak Korale Planters' Association, Mr. Walter gives a general survey of the activities of the new Low-Country Sub-Station. Those interested in the production of tea at the lower elevations in Ceylon will learn from this article how their special problems are being tackled.

When I started preparing this paper I had in mind as its title : " The Programme Of Research In The Low-Country ". However, in order to avoid giving merely a bare outline of the experimental work, I decided to include some of the general background of each experiment with the result that, I think, a more apt title would be : " A Survey Of Some Low-Country Problems, And How They Are Being Tackled ". I would add that, partly in order to give as comprehensive a picture as possible, and partly because research in the low-country is still in its initial stages, I have inevitably had to depart from the usual technique of developing fully one or two subjects of special interest to any particular district.

In outlining the programme of research that is in progress, or planned for this year, I would remind you that arrangements have been made to lease 10 acres of land (either cleared or due to be cleared shortly) on Vogan Estate (Matugama) where we also have facilities for carrying out experiments in old tea.

The main headings pertaining to these experiments are as follows :—

1. Vegetative propagation.
2. Methods of centering.
3. Grafting.
4. The response to various levels of manuring.
5. The response, if any, to minor elements, and
6. Types of green manures, cover crops and shade trees.

In addition to these field experiments, which have already been laid out, the question of shade in the low-country is receiving attention. It is not yet certain, however, what aspects of this rather complicated subject it will be possible to investigate by field experiments with the staff available, since the subject is so involved that a number of field experiments—preferably duplicated in various districts—would be desirable. As a preliminary, however, I intend to do some flush counts with a view to determining the intrinsic effect of shade on yield, and will endeavour to collect data regarding the effects of *Albizzia moluccana* grown under various systems of management.

Although the Vogan management very kindly granted us every facility for carrying out our experiments, they were naturally unable to provide areas where the incidence of shot-hole borer and Rhizoctonia are serious enough for our purposes, so these experiments could not be centralised at Vogan. We are, however, very

*Address given to the Morawak Korale Planters' Association on 30th June, 1952.

much indebted to the management of Hapugastenne and Galbodde estates for giving us facilities—including staff quarters—for carrying out field experiments in connection with Rhizoctonia and shot-hole borer, while our thanks are similarly due to the proprietors of Ingiriya Estate, where a pruning cycle-cum-Rhizoctonia control experiment has been started.

So much for the outline of the various experiments that are taking place, and I would like here to acknowledge the ever-ready assistance with their conduct given by my Field Assistant, Mr. F. P. Jayawardene.

I will now give you some general information interspersed with a few details, about each of them.

I. Vegetative Propagation—We now have about two acres of selected clonal material established at Vogan to serve as a multiplication plot. Nearly 200 clones are represented, these having been selected either as fresh cuttings, or as rooted plants from estates all over the low-country. Although some of these plants are now sufficiently well grown to supply some cuttings, the supply is not yet equal to our requirements, as there is still about 2 acres of land actually cleared and ready for planting next year. The collection of further clonal material is, therefore, continuing and if any low-country estate is in a position to make any contributions we should be very glad to receive them.

While this subject really provides sufficient scope for a separate address, I should like to take this opportunity for making a few points in connection with it. My impression is that low-country planters are rather sharply divided into two factions—those that V.P. and those that don't—with a possible third one sitting on the fence ; it is to the latter two that the following remarks are particularly directed.

Although V.P. on up-country estates has come to be recognised as a normal part of estate routine since the advent of blister blight, it has, by comparison, lagged behind in the low-country—partly owing to the absence of a definite stimulus such as blister blight to make it imperative, and partly owing to the more difficult conditions in the low-country. I would suggest, however, that the only way to close the widening gap caused by the present trend of rising costs of production and declining prices for low-country teas is by a determined effort to raise yields, and also to improve quality. The only really effective way of achieving this seems to be to make the utmost use of selected high-yielding clones not only for new clearings, but also in conjunction with a vigorous programme of replanting areas whose yield is too low to render their upkeep an economic proposition. An important point to bear in mind is that in the low-country, quite apart from artificially created economic conditions, the life span of the tea bush appears to have definite limitations ; for instance, where too hard pruning n the past has been resorted to, and the sizes of the frames have been still further reduced by wood rot, this economic age limit appears to be as low as 25 years.

Although as already mentioned, vegetative propagation is not nearly so easy in the low-country as at higher elevations, judging from observations I have made on a considerable number of low-country estates, and from experience gained in the initial stages of our low-country sub-station, there seems to be no reason why vegetative propagation of selected clonal material should not be successfully used on a large scale at least in districts with a moderately sustained rainfall ; and in fact there are several estates I know which, in view of the encouraging results so far achieved, are proposing to plant up between 25 and 50 acres this year. Before attempting such large acreages, however, it is essential to gain experience with small scale trials, and I would mention the following points as being particularly worthy of attention :—

1. The plants must be put out in the field at the optimum stage of growth ; it is not, of course, possible to lay down exactly how long the cuttings should be in the

nursery before they are ready for putting out, as the rate of growth varies considerably, not only in different districts but between different clones. It is probable, however, that 6 months and 1 year represent the lower and upper age limits respectively.

2. Special care must also be taken to ensure that the cuttings have just the right amount of shade in the nursery ; in the low-country cuttings are far less tolerant of shade, yet of course, the maximum degree of humidity has to be maintained—the necessary balance between the two being achieved only by constant supervision.

3. It is also essential that the rooted plants should be well shaded either with protection baskets or fern when they are put out into the field, for the initial period of establishment is undoubtedly the most difficult ; once established, however, only comparatively few casualties need be expected during the dry weather months of the following year.

With regard to the points on which the selection of clones should be based, it goes without saying that high yielding clones should receive top priority ; there is no short cut to the method widely adopted of selecting large numbers of apparently suitable bushes for trial, and rigorously discarding the ones that turn out to be unsuitable, with the percentage and type of rooting as the most important criterion. In some districts resistance to blister blight is of course a factor of major importance, while in others the selection of eelworm resistant types may have far reaching advantages.

II. Grafting—Although the process firstly of selection, and secondly of development of large numbers of cuttings for propagation from multiplication plots is inevitably a slow one, it is possible that grafting of selected material on to mature bushes may provide a means of side-stepping multiplication plots, thus effecting a very large saving in time. I mentioned in a book review published in the " *Tea Quarterly* " some time ago, that this method was commonly practised in Java, and I intend to do some small scale experiments with it very shortly. In the meantime I have nothing further to add regarding the method.

III. Centering—Another aspect of work on new clearings, which is not, however, confined to vegetative propagation is that of centering, and the four methods in common use are being carried out side by side on our new clearing. Again, planters seem to be sharply divided on the question of the best method, most appearing to favour a series of annual cuts at 3", 6", 9" and 12" (or thereabouts)—bringing the bushes into bearing in 4-5 years. Although it is true that, by this method, low-branching frames are produced, it has the inherent disadvantages, firstly that a considerable amount of growth is lost unnecessarily—a wastage of energy which might have been used to better advantage in thickening the frame—and secondly that a cut low down on the main stem inevitably renders it liable to the entry and development of wood-rotting fungi, since naturally the greater the thickness of the wood, the longer is the time required for it to callus over completely.

I would, therefore, take the opportunity of commending for trial the 3 other methods—namely, thumbnail pruning, pegging down and layering, all of which are equally applicable to vegetatively propagated plants and seedlings. In these methods the knife is not used at all, so that none of the losses normally associated with the centering of young plants—especially in the dry zones—need be expected.

" Thumbnail " pruning produces bushes with a good even spread, though it is perhaps not the best method to use with some V.P. clones which are characteristically poor branchers.

" Pegging-down ", as its name implies, consists merely of bending over and pegging down the young shoots when they reach about pencil thickness ; any desired shape of bush can be produced, the plucking table being eventually formed merely by tipping the numerous vertical shoots which develop at the required height.

" Layering " is essentially similar, except that the branches are bent down and covered with earth for several inches ; in order to achieve the best results, it is desirable to trench the ground before planting—alternatively the ground near the point of layering must be well dug—and neglect of these precautions may account for some of the prejudice against the method. Its effect is seen to perfection on steep hillsides, since the dense mass of roots and branches which develop—if trained along the contour—form an almost impenetrable barrier against soil erosion, and well defined terraces are built up in a matter of a couple of years.

IV. Manurial Experiment—I now come to the fourth main experiment, namely, a manurial one. This is a long term experiment designed to find out the response of the tea bush to various levels of the 3 main nutrient elements. Eight different treatments, each replicated four times, have been incorporated in the experiment containing the various combinations obtainable from 39 and 78 lbs. nitrogen per acre ; 18 and 36 lbs. phosphoric acid, and 24 and 48 lbs. potash per acre. This experiment has now been going on for just under a year, so it is obviously not yet possible to assess any results from it.

V. Minor Elements—Fifthly, a short term experiment has been completed designed to find out whether the tea bush shows any response to minor elements such as boron, manganese, etc., and hence to determine if any of these minor elements is a limiting factor with regard to yields. For the purpose of the experiment a " cocktail " mixture of a number of elements was sprayed at weekly intervals over a period of two months and the yields compared with unsprayed plots. As the yields from the sprayed and unsprayed plots were almost identical, the experiment showed that minor elements do not, in fact, have any effect on yields—a result which has been confirmed by other similar experiments in the mid and up-country districts.

VI. Green Manures, Cover Crops & Shade Trees—Sixthly, the question of the best types of green manures, cover crops and shade trees is being investigated, and some 30 different species are under trial. Small areas of Guatemala grass, Napier grass and sunflower—all of which are invaluable for thatching and mulching —have also been established.

Again there are a few points I should like to make here in connection with these:–

(i) **Green manures**—Although the contribution bush green manures make as a valuable source of nitrogen and organic matter is well known, I feel that no opportunity should be missed of further pressing their importance, since there are still far too many new clearings in the low-country where the soil remains exposed for 3–4 years, except for the very inadequate protection provided by the young tea plants and the shade trees. This unnecessary exposure causes not only losses of the valuable top soil by erosion, but a further reduction of the already sparse amount of organic matter in the soil by insolation. In windswept districts their value as low wind-breaks is apt to be overlooked, as well as the contribution they make towards shading the young plants during the all important time gap till the shade canopy is established. In this connection I feel that insufficient use is made of their potentialities, and the following suggestions are put forward as variations of normal estate routine :—

(*a*) Where tall, bushy species such as Tephrosia are grown a single bush should be left every few yards when the rest of the crop is lopped or dug up.

(*b*) Greater use could be made of tall growing species such as *Indigofera dosua*, and *Crotalaria agathifolia* to provide overhead shade ; these might well be intermixed with comparatively short growing species, such as *C. usaramoensis*, which would be grown to provide the main bulk of loppings.

(*c*) When your clearing programme gets ahead of your planting programme every effort should be made to complete the planting of the cleared

area with shade trees and bush green manures so that by the following monsoon, when the young tea plants are put out, the shade canopy is already there.

(*d*) To suggest the routine establishment of shade trees on all clearings a year before the tea plants are put out will probably in most cases be regarded as " counsel of perfection " which hard economic facts do not allow to be fulfilled in practice, but the system does appear to have a very definite practical application in the case of clearings that are a mass of boulders and rocks from which the heat radiation—in the absence of shade—is intense.

(*e*) Greater use could be made of Guatemala grass and Napier grass for thatching—especially new clearings—and it is suggested that small areas be set aside for growing them.

(**ii**) **Cover Crops**—Although the old adage that " the best cover for tea is tea " remains as true as ever, there are remarkably few estates in the low country that can boast of a 100% cover of tea, and one does not usually have to look far on any estate to find areas where cover crops could be used with advantage. The requirements of the tea plant are, however, somewhat exacting and the ideal cover crop must fulfil the following requirements :—

It must not climb up the young tea plants.

It must have a sufficiently spreading form of growth to give fairly complete soil cover.

It must have a shallow rooting system so as to avoid competing with the tea for nutrients.

It should preferably be thick enough to inhibit weed-growth—yet it should not be so thick that it forms a dense mass of matted roots.

Needless to say, such a cover crop is difficult to find, and I am doubtful if the perfect one exists. While it is, of course, too early to anticipate the results of the trials of various cover crops which are being made, several of the indigenous ones appear promising—notably *Desmodium triflorum*, a dwarf-leaved species commonly found on lawns ; gotukola, which grows very well in this district, and *Desmodium heterophyllum*. These latter two are somewhat prolific, and will probably have to be forked in periodically, in which case contour strip forking is recommended.

Amongst other well known ones, *Indigofera endecaphylla* may be suggested, and (especially for the top of terraces, steep banks and drains) *Desmodium ovalifolium* ; while among comparatively unknown exotic species which, of course, have the disadvantage that seed is difficult to get in any quantity, I would mention *Alysicarpus* species, *Cassia mimosoides*, and *Stylosanthes*.

(**iii**) **Shade Trees**—Thirdly, regarding types of shade trees. Although it is most unlikely that any tree will be found that will give a greater weight of loppings in the low-country than Gliricidias and *Albizzia moluccana*, there is room for trial of other trees that give a light, feathery shade ; of these I would mention particularly *Indigofera teysmanii* (which is fast growing and does well in the low-country), *Sesbania cinerescens*, *A. stipulata* and *A. sumatrana*. *Derris microphylla* and *Leucaena glauca* also come into this category, but they have an unfortunate habit of sending up large numbers of root suckers.

Further, the question of wind-breaks does not appear to have received the attention from planters that it merits. While it is difficult to recommend a really suitable wind-resistant tree for planting in the tea, there are a number of indigenous species that are highly suitable for planting along boundaries, *e.g.*, mango, jak, casuarina and toona of which far greater use could be made. Of the exotic species, *Spathodea*, *Cupressus macrocarpa*, and *Cassia siamea* are probably the most suitable.

The most satisfactory way of dealing with the problem is of course, to leave strips of jungle when opening up land in wind-swept situations and some wonderful opportunities have been missed in the past owing to the oversight of the original early planters.

VII. Diseases—I come now to the general subject of diseases, and will deal firstly with the fungus known as *Rhizoctonia solani*. This fungus occurs universally in the low-country, and though it is perhaps widest known for the damage it does to all types of seedlings in nurseries it can cause serious damage on mature tea. The presence of the fungus usually begins to make itself felt in infected fields at about the ninth month from pruning, from which time it rapidly increases in severity ; it thrives in damp, shady situations with poor air circulation, and especially where there are clusters of dead leaves matted together by horse hair blight. Not only is the mature foliage attacked, but also severe die-back of the young flush may be caused so that yields can be seriously affected. Fortunately, Rhizoctonia, like blister blight, is susceptible to copper fungicides such as Perenox, but complete eradication is difficult or impossible owing to the fact that it can survive in a dormant highly resistant state in the soil for a considerable time.

Such is the background of the Rhizoctonia control experiment which has been laid out in duplicate on Hapugastenne and Galbodde Estates (near Ratnapura). Five treatments are to be compared in this experiment—namely, spraying with Perenox, spraying with Bordeaux mixture, high tipping (with the object of making the micro-climate unfavourable to Rhizoctonia by improving the air circulation) ; thatching with grass, such as Guatemala grass, and the weekly removal of diseased leaves at plucking time.

Pruning Cycles—Although pruning cycles and diseases do not at first sight appear to have any connection, I have included the subject under this heading on account of the close relationship that exists between the optimum length of the pruning cycle and the presence or absence of diseases such as Rhizoctonia.

As you know, in the low-country comparatively wide variations in yield may be produced by only slight variations in the cycle length ; while these yield variations are often such that different fields on the same estate may be run on different cycles, the main significant factors affecting yields—apart from altitude are :—

(*i*) the type of pruning employed.

(*ii*) the manurial level.

(*iii*) the presence or absence of limiting diseases such as Rhizoctonia.

(*iv*) the cycle length.

It is not desirable, however, to introduce too many variable factors into one field experiment, so manurial limitations have been excluded by adopting a uniform level of manuring 50% above calculated requirements. For the same reason the " cut across " has been accepted as the " normal " method, while a " hard " prune leaving rim-lungs is being given to all plots at the start and thereafter every six years or other convenient period.

We are thus left with two factors—cycle length and effect of the presence or absence of Rhizoctonia—to be investigated. Accordingly, a pruning cycle experiment, incorporating these factors has been laid down on Ingiriya Estate, the field chosen having in its last cycle been severely attacked by Rhizoctonia. Four cycle lengths, namely, 18 months 2 years, 2½ years and 3 years have been decided on, and half the plots comprising each cycle are to be sprayed with Bordeaux mixture as a means of eliminating the effect of Rhizoctonia.

Although much of this may appear to be of purely academic interest, an illustration of its practical importance may be given by pointing out that the incidence of shot-hole borer has been found to be greatly reduced when the pruning cycle is lengthened ; on the other hand, a vicious circle is created if this method of control is used without reservations on many areas in the low-country, owing to the consequent increased incidence of Rhizoctonia.

Shot-hole borer—That brings me to the next subject being investigated—namely, shot-hole borer. Mr. Redman King, Dr. Gadd and Mr. Austin did a series of experiments extending over a period of about 20 years in our Passara Sub-Station in the Uva district ; the advice given as the result of their researches is to extend the pruning cycle, and on Uva estates where this has been carried out, a considerable improvement in the position has resulted.

The conditions in Uva are, of course, very different to those in the low-country where it was recently decided that the whole question should be investigated. This required the full time services of an entomologist on the spot, and Mr. Austin has, accordingly, been temporarily transferred to Hapugastenne Estate, in the Ratnapura district. He is now making a preliminary survey to find out the degree of shot-hole borer infection there—with special reference to new clearings—and to find out whether the life history of the beetle follows the same pattern in the low-country as it does in Uva. No further details of his activities can be given at the moment, but we hope that the beetles in the neighbourhood can look forward to having a thin time as the result of experiments now in progress.

MINOR ELEMENT NUTRITION OF THE TEA BUSH IN CEYLON

F. Haworth

Tea provided one of the early examples of a deficiency disease occurring in plants. In 1929–1931 *tea planted in Nyasaland was devastated by a disease known as "Tea Yellows". This was shown by H. H. Storey and R. Leach to be due to a deficiency of the element sulphur. These two workers had the great satisfaction of finding a spectacular cure for a disease which had been described by an eminent authority as "unquestionably one of the most serious diseases to which the tea bush is liable".*

The importance of mineral elements other than nitrogen, phosphorus and potash to the full health of plants has been accentuated by progressive studies on plant nutrition. Some plants require considerable amounts of calcium, magnesium, iron and manganese and sulphur in addition to the three major elements nitrogen, phosphorus and potash.

In recent years it has been found that the most minute traces of other elements such as boron, cobalt, copper and molybdenum are also essential for the normal growth of a number of crops.

Where more or less complete deficiencies of nutrients occur, some crisis is usually precipitated and attention is thereby drawn to the condition. In other cases where the essential elements are present in the soil but are unavailable, or are in amounts inadequate for full health and vigour, the effects are insidious and most difficult to recognise. The investigations described in this article are, therefore, of considerable importance.

The nitrogen, phosphate and potassium requirements of the tea bush are reasonably well known and Eden[1] has described in detail the crop response consequent upon different levels of application of the three nutrients mentioned. The manurial experiments conducted to date have enabled a rational manurial policy to be recommended and it is only in the case of very high yielding fields that there is somewhat of a gap in the knowledge of the nutrient requirements.

However, plants in general require many more elements than the nitrogen, phosphorus, potassium trio to enable them to grow satisfactorily. Bond[2] reviewed the role of minor nutrients in plant life and drew attention to some of the more common diseases which had been shown to be attributable to shortages of nutrient elements.

Since that date (1941) very many more cases of diseases or lack of optimum production due to minor nutrient deficiencies have been identified, and nearly every crop plant has been involved in one area or another. Quite recently Evans[3], working in Trinidad, showed that cacao, growing on what has been for many years the most highly productive soil in the island, gave visual responses to the application of iron, manganese and copper compounds to the leaves. The soil type in question, Montserrat clay loam, had been regarded as approaching the ideal soil for cacao, but this view may need modification in view of the recent findings.

Tea in Ceylon is not known to suffer from any minor nutrient deficiency although within the last few years symptoms believed to be associated with a deficiency of the macronutrient potassium have become apparent.

The cause of this apparent potassium deficiency is probably to be found in the cessation of potash manuring during the war and immediate post-war years coupled with relatively high levels of crop removal during that period. Similar symptoms can be observed on the plots on St. Coombs which have received no potash manures for over 20 years. The fact that no specific minor nutrient deficiency symptoms have yet been found on Ceylon tea does not necessarily mean that minor nutrient shortages do not exist.

There are a few estates where, in spite of quite high applications of nitrogen, phosphates and potash, no crop response has been obtained. In one such area the tea is well grown and appears to be healthy, but the yield per acre is very disappointing being only some 500 lbs. made tea per acre per annum where from the appearance of the tea twice that yield might reasonably be expected. In this area the application of cattle manure at the rate of 6–8 tons per acre has given remarkable increases in yield whilst more than the equivalent amount of nutrients given as inorganic fertilizers has been without effect.

The soil in question is a fine sandy loam of considerable depth, low in clay and organic matter (1%) and very freely drained. It tends to dry out rather rapidly in the dry weather. However, it is difficult to believe that the small amount of organic matter supplied by an application of from 6–8 tons per acre of cattle manure can have had a material effect on the waterholding capacity of the soil or on the structure of the soil.

The possibility that the cattle manure supplied a minor nutrient which was previously lacking in the soil and which was not contained in the inorganic manure mixture (which gave no crop response at all) was considered and an experiment laid down to test this possibility.

The experiment consisted of ten plots each containing three hundred bushes. Five plots chosen at random were treated and five plots remained untreated as controls. The minor nutrient mixture containing all known essential elements was applied to the foliage of the bushes as a spray at weekly intervals for the 5 week period before tipping. The whole applicational part of the experiment was carried out in dry weather.

Tipping weights were recorded and the weights of flush removed at nine day intervals for a period of four months after tipping were also taken. There was no response whatsoever which could be attributed to the treatment. This experiment was repeated on three other sites, the relevant details of which are given below. In no case was any response obtained.

Site 2—This site was in the Uva Province and the soil is derived from a quartzite outcrop. The soil is gravelly and freely drained with a good humic topsoil of some 10″ depth. A manurial experiment, involving the three nutrients, nitrogen, phosphorus and potassium has shown that shortage of potash is one of the limiting factors to production on this soil type. The field on which the minor nutrient experiment was carried out had been adequately fertilized with nitrogen, phosphates and potash.

Site 3—This site was on St. Coombs Estate Field No. 3 where the soil is dark red brown clay of good structure. The black humic topsoil extends to a depth of 9″–12″ and the soil is of free draining character due to good sub-soil structure.

Site 4—This was located on a low-country estate. The soil is a red, medium clay loam, sandy in patches. The soil is freely drained although there is a tendency to iron pan formation at depths varying from 2 to 4 feet. On the plots which were used this iron pan formation was very little in evidence.

The possibility that the nutrients applied to the bushes in the form of a spray were not absorbed into the leaves cannot be ignored, but since it has been shown by Lamb [4] that the copper ion can be absorbed into the tea leaf when sprayed onto the leaf surface, the possibility of the non-absorption of the applied nutrient appears to be remote.

It may be concluded, therefore, that for the present, minor element deficiencies are unlikely to be of importance in limiting yields in the main tea growing areas of Ceylon.

With the current replanting of certain areas with high yielding clonal material the position will need constant review since a high yield means a greater drain on the soil nutrients and consequently a danger of earlier exhaustion of the soil reserves.

Thanks are due to the Superintendents of Nayabedde, Gonakelle and Vogan Estates, and to Messrs. G. D. Austin and T. E. Walter of the Passara, and Low-country Sub-Stations respectively for their assistance with these experiments.

REFERENCES

(1) Eden, T.—Monographs on Tea Production in Ceylon, No. 1, 1948.

(2) Bond, T. E. T.—Deficiency diseases and the role of " Minor Elements " in plant life. *Tea Quarterly*, Vol. XVI, pp. 9–15.

(3) Evans, H.—Report of the Cacao Conference, London 1950.

(4) Lamb, J.—Annual Report for 1944, Bulletin No. 26. p. 54.

INFECTION CHAINS AND ACACIAS

B. N. Webster.

It is hoped that this note may serve as an introduction to the following paper by Dr. Gorrie, and that it may explain why the Tea Research Institute is anxious to collect as much information as possible on the species of Acacia at present growing on, or near, tea estates. A brief description of infection chains, and their importance to the plant pathologist, is followed by an explanation of the part played by certain species of Acacia in the infection chain of the so-called "Cercosporella" disease of tea.

An infection chain has been described as "the serial transmission of infective material from host to host". This chain may be either interrupted, or continuous, depending upon whether the pathogen is able to pass part of its life cycle separated from its hosts, or must, of necessity, pass directly to fresh host material. Examples of the latter type of chain are commonly met with in human diseases, where either direct contact, or "droplet" infection occurs. The pathogens concerned form neither resting stages nor spores, and are unable to exist saprophytically, *i.e.*, on non-living material. In plant diseases this type of infection is the exception rather than the rule, being met with only in the viroses and certain bacterioses such as the bacterial canker of stone fruits. It may be argued that the blister blight fungus, and other similar fungi, have such a transient existence as spores, which do not, as far as is known, possess powers of resistance, that they should be included in this category.

The great majority of plant pathogens, however, belong to the group having interrupted or discontinuous infection chains and are able to exist through long periods on dead roots remaining in the ground etc. Many of these form, during their period of saprophytic existence, resting bodies, such as the sclerotia of the species of *Corticium* causing black rot and of *Sclerotium rolfsii* the common nursery fungus. Others form resistant spores during certain stages of their life cycle, and the 'perfect' spore forms of the Rosellinia and Ustulina root disease fungi, with their relatively thick walls, provide an example. These spores are able to exist for fairly long periods until suitable conditions of environment bring about their germination and reinfection of suitable material.

The links of an infection chain are the various hosts of the pathogen, and the weak links in the chain provide the answer to control. It is thus of great importance to the pathologist that he should gain a thorough knowledge of the whole chain in order to find the weakest link on which to concentrate his attack.

The major category of discontinuous chains may be further subdivided into two more divisions, that of homogeneous chains and heterogeneous chains. In the former, the pathogen is limited to one host species, or group of species, whilst in the latter the pathogen possesses more than one, often many, hosts, and in addition may be able to exist saprophytically. The significance of these two chain types is that in the first, the links of the chain are well defined, and any weak links are fairly obvious, whilst in the second there is a possibility that links formed between the parasitic and saprophtic stages of existence, and vice versa, may be obscure.

To take a well known example of the first type, the blister blight fungus, *Exobasidium vexans*, is host specific to tea, and the weak link in its infection chain is furnished by the short-lived, susceptible spores. It is impossible to eradicate the fungus once established, except by removal of infected leaves, so control must be directed to the transmission stage. It can be effected in several ways, principal amongst which are the destruction of the spores on germination by prophylactics applied to the host, and the removal of susceptible host material by hard plucking.

Examples of heterogeneous infection chains are furnished by the majority of the fungi commonly causing diseases of tea. Few ever assume epidemic proportions, and the principal method of control comprises the removal and destruction of infected material, coupled with the removal of susceptible material, for example the clearing of leaf litter during an outbreak of the Rosellinia disease. Examples of chains with fairly obvious weak links, in diseases which occasionally assume local epidemic proportions, are afforded by the brown blight fungus, *Colletotrichum camelliae*, and the Poria root disease fungus, *P. hypolateritia*. In each instance control is achieved by denying host material to the pathogen. In the first, where the pathogen is unable to effect direct entry into the tea leaf by endeavouring to prevent leaf damage, typically caused by sunscorch, and in the second by removing a ring of healthy tea bushes from around the locus of infection, in addition to the removal of infective material.

The so-called " Cercosporella " disease of tea, caused by the fungus *Calonectria theae* Loos, falls into this category of diseases having heterogenous infection chains. It is not host specific, having a wide range of hosts, including Acacia species. Albizzia sp., Eucalyptus sp., Tephrosia sp., etc., whilst in addition it is able to survive as a saprophyte on Acacia and tea leaf litter. Its full host range is not completely known, and attempts are now being made at the Tea Research Institute to extend our knowledge of its hosts, both as a parasite and as a saprophyte. It is not well adapted as an active parasite of tea, spore infections being limited to the very young flush, but it is however, an active parasite of *Acacia decurrens*, which suffers severe defoliation. The infected leaflets of the Acacia fall onto the underlying tea, and the actively growing fungus is able to penetrate the mature tea leaves and considerable damage follows.

The saprophytic stages in the life history of this fungus are followed in the litter of fallen Acacia and tea leaves on the ground. The conditions of high humidity met with under a cover of tea are ideal for the development of the fungus, and two types of spores are produced, representing two phases in the life cycle of the fungus (as distinct from the infection cycle). The so-called imperfect spores are produced in large quantities and may infect any of the hosts mentioned above, as well as continuing the saprophytic existence. The perfect spores, resulting from a possible sexual process, are produced within closed fruiting bodies and constitute a possible resting stage in the life cycle.

The significance of *Acacia decurrens* in the infection chain of *Calonectria theae* is that it constitutes the means whereby severe infection of the tea results. Thus it forms a weak link, in that it is removable. To what extent this disease can develop in the absence of Acacias is not known but there have recently been a number of reports of apparently severe flush infection although the fungus has not actually been recoverable from the flush, in areas where no Acacias are growing. It has, therefore, been argued, that if such infection can indeed occur, there seems little point in not growing Acacias, particularly as, in some of the areas where the disease is most prevalent, Acacias constitute the only low shade and wind break trees that it is possible to grow.

To revert to the consideration of weak links, and points for attack referred to above, it must be emphasised that practical control measures must be economically feasible. Little is known of the susceptibility of this fungus to prophylactic sprays, but it is known that copper spraying directed primarily against blister blight does

not protect tea from *Calonectria theae*, ("Cercosporella".) Any copper spray of greater concentration than this would be uneconomical. Removal of Acacias, or rather the avoidance of Acacias is economical, but shade is necessary, so the possibility of growing Acacias and yet removing susceptible material must be accomplished. Accordingly, trials are to be made of growing Acacias, and lopping them frequently during wet and misty weather, when the disease is prevalent. Whether the loppings must be removed or not will depend on the severity of spore infections building up as a result of fungus growth on the litter.

The use of resistant materials must also be considered, and infectivity trials are being made on a number of the species referred to in Dr. Gorrie's key. Not all are available, however, and so we should welcome information on any of the species which may be identified, particularly as to their suitability for growing above 5,000 feet.

THE INDENTIFICATION OF AUSTRALIAN WATTLES (ACACIAS) INTRODUCED INTO CEYLON

R. M. Gorrie, D. Sc., & T. B. Worthington

Out of several hundred Acacias indigenous to Australia, a number amounting to over a dozen have at some time or other been introduced into the Ceylon highlands, partly as ornamental shrubs but more often as likely shade trees in tea. The Acacias as a whole are easily hybridised, especially within the more closely allied groups, so it is more than likely that local hybrids have already been produced amongst the naturally regenerated crops of Acacia now well established in the jungle fringes of Hakgala and the Nuwara Eliya golf course, and in the shrubby wild lands adjoining old established tea estates.

As a means of identification, the following key may be of some interest and value to planters whose land is 4500 ft. and upwards above sea level, as this is the level at which the Australian wattles are commonly established.

The genus as a whole is subdivided into 6 sections, the first 5 of which may carry two kinds of leaf *i.e.*, (*a*) normal leaflets, usually minute and in rows on comb-like pinnae or leaf-stalks, and (*b*) reduced leaves or *phyllodes* usually taking the form of a strap-like leathery leaf 1 to 6 inches long. The phyllode may have normal leaflets at its tip because it is really a branch. The sixth section has no phyllodes and only normal divided leaflets. Thus we have :—

(*i*) Pungentes, pungent bushes with reduced leaves.

(*ii*) Calamiformes, rigid bushes.

(*iii*) Uninerves, phyllode flattened, leaflike, with a single nerve, flowers in globose heads.

(*iv*) Plurinerves, phyllode flattened, leaflike with more than one nerve, flowers in globose heads.

(*v*) Juliflorae, phyllode leaflike, flowers in cylindrical spikes.

(*vi*) Bipinnatae, no phyllodes but only bipinnately divided leaflets on normal leaf-stalks, flower heads in axillary racemes but the upper ones forming an open spray or panicle.

This last group includes the three commonest wattles, (*decurrens*, *mollissima*, and *dealbata*) which form the backbone of the South African wattle bark industry. It also includes the indigenous dry zone or Ceylon low-country thorn trees which are described in Lewis' " Vegetable Products of Ceylon ", so these are not repeated here.

Section I Pungentes.

(1) *Acacia juniperina*, a juniper-like rigid shrub with a pungent smell, phyllodes spreading with prickly point and articulate on branches (joint reversible), small yellow flowers on $\frac{1}{2}''$ stalk, pod falcate, $2'' \times 1/8''$, constricted between seeds to form a wavy edge.

Section II Calamiformes. None in Ceylon.

Section III Uninerves. Phyllodes leaflike with single main vein.

(2) *Acacia falcata*, angular branches, glabrous (shiny) foliage, phyllodes falcate or sword shaped, 3 to 6″, with an obscure marginal gland near the base, flowers 20 in a head, pod narrow.

(3) *Acacia pycnantha*, " broad leaved golden wattle ", similar to *A. falcata* but marginal gland large and near base of leaf, yellow flowers numerous, pod narrow, same width throughout.

(4) *Acacia podalyriaefolia*, " large leaved silver wattle " or " glaucous acacia "; mucronate ovate broad leaf $1\frac{1}{2}'' \times \frac{1}{2}''$, very waxy glaucous grey, flowers golden yellow, much longer sprays than the leaves, pod $\frac{3}{4}''$ broad. Flowers profusely at 4000–5000 ft.

(5) *Acacia cultriformis*, " knife-leaved acacia ", like *podalyriaefolia* but only a large bush, phyllodes slightly smaller, triangular-falcate in shape with thickened margin and a marginal gland and terminal prickle, flowers 10 to 20 in a head, pale yellow, twice a year.

Section IV Plurinerves. Phyllodes large with several parallel veins, flower heads solitary or few on a stalk.

(6) *Acacia melanoxylon*, " blackwood ", a tall tree, phyllode 2 to 4 inches long with 3 or more longitudinal veins, narrowed to base, flowers 30 to 50 in a compact pom-pom 1/6″, lemon cream in colour, pod flat 1/3″ broad, coiled; true leaves when present are on 2–3 pairs of $1\frac{1}{2}''$ pinnae each bearing 10–20 pairs of minute leaflets distinctly spaced, leaflets develop from tip of leaflike phyllode. Common in gardens around 6000 feet.

Section V Juliflorae. Flowers in elongated spikes like willow catkin.

(7) *Acacia verticillata*, " whorl-leaved acacia ". A bush with rigid branches and phyllodes in whorls of 3 to 6, pungent $\frac{1}{2}''$ pointed, awl-shaped, flowers a dense spike on a short stalk, pod 2″ slender.

(8) *Acacia longifolia*, " white sallow ", small tree with large phyllodes 3″ to 6″, oblong with a dense pattern of crossing veins between 3 and 5 main nerves, young branches shiny, angular, not pungent; flower a bright yellow spike 2″ like a willow catkin, pod 3″ to 6″ long with a wavy margin between 6 to 12 isolated seeds, flowers twice a year. MacMillan page 169 gives " Sydney Golden Wattle ", but " white sallow " seems a better name. Moray Estate, 4600 ft, unsatisfactory for lopping.

(9) *Acacia linearis*, phyllodes 6″ straplike with one prominent vein, flower spike loose, 1″ to 2″ long, yellow, pod linear-cylindric.

Section VI Bipinnatae. No phyllodes, only normal foliage in rows of very small leaflets. Flowers in globular heads.

(10) *Acacia elata*, " mountain hickory " of New South Wales, where it is a tall tree; seeding round Hakgala. Leaves 8″ to 12″ divided into 4 pairs of pinnae, each with about 14 pairs of $1\frac{1}{2}''$ leaflets, ovate, pointed, flowers pale yellow, pod $3'' \times 3/8''$ with 8 seeds, each separated in the straplike pod seeds with lentical markings. Nuwara Eliya Racecourse and Liddesdale.

(11) *Acacia pruinosa*, leaflets $\frac{1}{2}''$ long, 25 pairs on 2 to 4 pairs of pinnae, each with a prominent gland on the stalk halfway from the base to the first pair of pinnae, flowers sulphur-primrose, pods $3'' \times 3/8''$.

(12) *Acacia baileyana*, small tree of limited occurrence in New South Wales, leaflets 17 to 20 pairs, minute, crowded on 2 to 4 pairs of short pinnae with a cup-shaped gland between each pair of pinnae, flowers yellow in long sprays, pod 3″ with 10 small seeds. Not located so far.

(13) *Acacia farnesiana*, " the Fragrant Acacia ", heavily scented bush with many branches from base, stipules at base of leaf form paired spines, pinnae 4 to 6 pairs with leaflets 10 to 20 pairs, 1/5″ long, pods thick, spindle shaped, 2″ to 3″ long with seeds embedded in pith.

(14) *Acacia decurrens*, " the green or feathery wattle ", leaflets distant, very small, elongated, 1/5″, base of main leaf-stalk decurrent, *i.e.*, forming a ridge on the twig below its junction ; flowers bright yellow ; pod straight, constricted between seeds, seed tick-like with a yellow tip. Has seeded freely on Ohiya Forest Department plantations.

(15) *Acacia mollissima*, " the black wattle ", leaflets minute crowded, with 50 pairs on each of about 14 pairs of pinnae, flowers dirty cream, pod flat, narrow, constricted deeply between seeds, young foliage yellowish, but greyish when old. MacMillan on page 171 gives this as *A. decurrens var mollissima*, but is now has specific rank.

In spite of the Australian botanists' insistence upon the separate entities of *Acacia decurrens* and *mollissima*, we have not succeeded so far in finding any satisfactory points for differentiation. The form which we take to be *decurrens* regenerates freely in forest and even in mana grass in Uva and other fairly dry hill climates over 5,000 feet.

(16) *Acacia dealbata*, " the silver wattle " (a separate entity though a variety of *decurrens*), leaflets 1/8″ in 25 to 30 pairs on about 16 pairs of $1\frac{1}{2}$″ long pinnae, flowers chrome yellow, fragrant, flat pod *not* constricted between seeds, red inside with seeds widely spaced, young foliage white, heavy sucker regeneration from cut stumps, flowers twice a year. Ohiya and Kandapolla.

Notes on cultivation and propagation are given in MacMillan's " Tropical Planting and Gardening ". As the Tea Research Institute is interested in wattles as possible alternative hosts for fungus pathogens any notes on location, or specimens for identification, should be forwarded to Mr. B. N. Webster at the Tea Research Institute.

STUDIES IN BLISTER BLIGHT CONTROL

XI. DUSTING AGAINST BLISTER BLIGHT ON ALUPOLLA GROUP, RATNAPURA

C. A. Loos

Up to the end of 1950 field experiments on the control of blister blight had been confined to up-country areas. It had been assumed that below 1,000 feet elevation the disease would not be of economic importance, and that for mid-country zones at elevations from 1,000 feet to 3,000 feet a few years observation on the course of the disease would be required before any prediction as to the necessity for control could be made.

In May, 1951, Mr. A. Passingham approached this Institute on the problem of blister blight control in low and mid-country areas. Mr. Passingham was of the opinion that the disease had already become a menace in these areas, and he felt that the findings of up-country experiments could not be applied to low-country conditions in all respects. Particularly was he concerned with the frequency of dusting, having regard to the more rapid rate of growth of young leaf at lower elevations.

We were in full agreement with Mr. Passingham's view and were, therefore, very grateful to be able to avail ourselves of the opportunity to conduct field experiments in the Ratnapura area. Through the generosity of Messrs. James Finlay & Co., Ltd., and Mr. Passingham, suitable facilities, labour, fungicides, etc., were made available, and are herewith gratefully acknowledged.

Considering the possibility of both water and labour shortages under low-country conditions, it was decided that the type of control to be attempted should be protection with copper based fungicidal dusts. Accordingly an experiment was designed and laid down on Alupolla Group to test out the efficiency of " Cuprosana " dusts, containing 2, 4 and 6 per cent, of copper, at varying application rates and time intervals. The dusts were applied by :—

(*a*) The " Armada " portable hand duster.

(*b*) The " Whirlwind " power duster supplemented with " Armada " on areas out of range of the power machine.

In addition to the dust applications a field recovering from pruning was sprayed with a wettable copper fungicide, at the recommended concentration of 4 ounces in 10 gallons water, at weekly intervals. The sprayed area was for comparison with areas dusted with a 6 per cent. " Cuprosana " fungicidal dust.

The experiment was commenced in July 1951 and concluded at the end of December of that year. Final observations of control, on which this report is based, were made on January 13th, 1952.

In normal years, the severest blister blight attacks are experienced during the months of the south-west monsoonal rains. A second, but less severe, attack occurs during the latter part of the north east monsoon. In 1951, during the course of the experiment, due to the partial failure of the south-west monsoon severe blister blight attacks did not occur during that season. A fairly severe attack developed, however, in December at the tail end of the north east monsoon.

Table I shows the age of the tea fields from pruning, the type of appliance used, the acreages dusted and left unprotected for control comparisons, and the application rates per acre and the time intervals of applications.

Table 1. *Areas under experimentation and details of treatments.*

Plot No.	Appliance	Date pruned	Acreage		Copper percentage, application rates, and time intervals of application.
			Dusted	Unprotected	
1	Armada	Jan. '51	11	1	2% – 4 lbs. every 4 days
2	Whirlwind & Armada	Aug. '49	26	1	2% – 7 lbs. every 7 days
3	Whirlwind & Armada	Jan. '50	12	1	2% – 6 lbs. every 7 days
4	Armada	Dec. '50	1	1	4% – 5 lbs. every 5 days
5	Whirlwind & Armada	Feb. '51	3	24	4% – 4 lbs. every 7 days
6	Whirlwind & Armada	Jul. '51	32	0	* 6% – 5 lbs. every 4 days (14 applications) 4% – 6 lbs. every 7 days (17 applications)
7	Whirlwind & Armada	Aug./Sep. 1951	12	0	* 6% – 5 lbs. every 7 days (7 applications) 4% – 6 lbs. every 7 days
8	Knapsack sprayer	Jul. '51	6	0	4 oz. wettable copper fungicide in 10 gallons water–15 gallons every 7 days.

*6% dust used for a period immediately following pruning followed by 4% dust when recovery was advanced.

Table 2 shows the summary of control results achieved and the costs of control per acre, which have been worked out on the basis of a 28 day month. In the application costs are included the costs of transport, at 79 cents per mile, of labourers and materials. Costs of applications have, therefore, varied from time to time, depending on the number of acres dusted on any particular day and the distance of the experimental area from the estate factory.

Table 2 *Summary of control achieved, and costs of control per acre.*

Plot No.	Appliance	Fungicide	Application rate and interval	Cost for 28 day month			Control achieved
				Fungicide	Transport plus labour	Total cost	
1	Armada	2% dust	4 lb. every 4 days	9/60	4/71	16/31	Insufficient
2	Whirlwind & Armada	2% dust	7 lb. every 7 days	9/60	3/68	13/28	Very poor
3	Whirlwind & Armada	2% dust	6 lb. every 7 days	8/25	4/17	12/40	Very poor
4	Armada	4% dust	5 lb. every 5 days	12/16	9/34	21/50	Very Good
5	Whirlwind & Armada	4% dust	4 lb. every 7 days	5/94	3/70	10/64	Good
6	Whirlwind & Armada	6% dust *	5 lb. every 4 days	17/78	0/49	18/27	Very good to excellent
		4% dust	6 lb. every 7 days	10/42	1/70	12/12	
7	Whirlwind & Armada	6% dust *	5 lb. every 7 days	10/16	?	10/16	Very good
		4% dust	6 lb. every 7 days	10/42	?	10/42	
8	Knapsack sprayer	wettable copper fungicide	15 gallons every 7 days	2/88	7/24	10/12	Excellent

*6% dust used for a period immediately following pruning followed by 4% dust when recovery was advanced.

It should be noted that the above costs of dusts are calculated on average prices of deliveries on the estate during 1951. The prices prevailing then and now (Feb. 1952) are as follows :—

	1951 deliveries on estate (average) per lb.	Prices (Feb. 1952 f.o.r. Colombo) per lb.
2% Cuprosana	34.03 cts.	37.05 cts.
4% „	43.43 „	45.98 „
6% „	50.81 „	54.02 „

General Summary of Results

2 per cent. "Cuprosana"—This precentage of copper in the dust, at the application rates and time intervals chosen, proved unsatisfactory for the control of blister blight. The application rate of 4 lbs. every 7 days gave light control in comparison with the area left unprotected. The numbers of blisters on leaves varied over a fairly wide range of intensity whilst die-back of plucking shoots was general and fairly severe. About 10 per cent. of the bushes showed severe attacks. The undusted area showed almost complete loss of crop following die-back.

4 per cent. "Cuprosana"—Applications of 5 lbs. per acre every 5 days gave very good results. The application rate of 4 lbs. per acre every 7 days, though good, was not as effective as 5 lbs. every 5 days. It may well be that the lesser degree of control obtained with 4 lbs. at 7 day intervals may not be adequate under normal monsoonal weather.

6 per cent. "Cuprosana"—5 lbs. every 5 days, on tea recovering from pruning, until recovery was well established and then 6 lbs. of 4 per cent. "Cuprosana" every 7 days have excellent results. The degree of control was as good as that given by spraying on 7 days rounds.

Copper Analyses

Dr. Haworth made copper analyses of the leaf secured from each experimental plot at each plucking. Although the method of field sampling is open to some considerable error, the estimations as a whole may be considered to have given fairly satisfactory results. Table 3 shows the copper contents found over the period of the experiment. As will be seen from the table, copper residues, except on a few occasions, can be considered satisfactory. It should, however, be borne in mind that weather conditions largely determine the copper residues at plucking. Dusting a day before plucking, in fine weather, may give residues for higher than the tolerance limit. Taking for example the copper analyses of pluck No. 4 of Plot 4, it will be seen that 103 p.p.m. of copper was recorded. That experimental plot was dusted with 5 lbs. of 4 per cent. copper dust three days before plucking. A shorter interval between dusting and plucking might well have resulted in a considerably higher copper figure.

Table 3. *Alupolla dusting experiment — Copper analyses of flush at each plucking. Total copper expressed as parts per million of dried leaf.*

Pluck No.	Plot numbers					
	1	2	3	4	5	6
1	18	17	18	19	19	16
2	21	16	21	24	18	
3	46	29	34	50	24	
4	49	22	45	103	27	
5	34	29	23	47	24	
6	24	36	67	32	25	
7	52	21	71	34	71	
8	31	20	28	25	36	
9	26	34	26	71	25	
10	47	25	25	43	32	
11	34	22	20	32	23	
12	36	25	25	31	24	
13	26	24	27	45	26	
14	45	25	47	26	22	23
15	26	24	34	25	41	50
16	50	20	24	68	88	43
17	22	16	20	17	15	19
18	21	16	20	24	22	21
19	32	22	32	40	28	25
20	59	50	31	37	38	55
21	50	33	26	53	25	35
22	45	27	29	59	43	28
23	77	28	28	43	39	91
24	34	31	28	45	30	31

Key to Plot numbers

Plot 1 Hand dusted. 4 lbs. of 2% dust every 4 days

Plot 2 " Whirlwind " and " Armada " dusted— 7 lbs. of 2% dust every 7 days

Plot 3 " Whirlwind " and " Armada " dusted— 6 lbs. of 2% dust every 7 days

Plot 4 Hand dusted—5 lbs. of 4% dust every 5 days

Plot 5 " Whirlwind " and " Armada " dusted— 4 lbs. of 4% dust every 7 days

Plot 6 " Whirlwind " and " Armada " dusted— 5 lbs. of 6% dust every 4 days from 6th July to 29th August and 6 lbs. of 4% dust every 7 days up to 27th December.

Acknowledgments

We wish to record our thanks to Mr. T. Whyte who initiated the experiment and Mr. R. V. Hinton who took over when Mr. Whyte proceeded on leave. Their help and co-operation are gratefully acknowledged.

Addendum

Mr. Hinton has kindly given his observations with regard to dusting. These observations which are substantially the same as our own are set out below.

" 1. Dusting by either " Whirlwind " or " Armada " requires the very strictest supervision, and training on the part of the person in charge. He should at all times be at the extreme carry of the dust and untreated areas

should be noted for supplementary treatment with hand machines. An intelligent labourer should be at the opening and closing handle of the "Whirlwind" to operate the dust as signalled by the person in charge. Dust should be blown in puffs rather than a continuous stream.

2. I prefer line abreast for operating "Armada" dust guns, distance between operators being determined by the strength of wind, etc.

3. On no account should dusting take place after air currents have started to move upwards, *i.e.*, about 8-30 a.m. In the low-country, dusting should recommence about 5 p.m. This is most important and leads to a complete waste of dust if not watched.

4. Use has been made of the "Armada" dust gun, which has been found to be most efficient, but requires careful handling. The cog drive is inclined to wear rapidly, spares for which are very difficult to obtain.

5. It has been proved on this estate that protection can be obtained by dusting immediately after pruning.

Finally, dusting can be effective, provided bad supervision is detected."

Appendix *

Following a preliminary report on the above experiment, Messrs. Harrisons & Crossfield, Ltd., have requested that some further comment be made on the costs of dusting compared with those of spraying over large areas, as distinct from an experimental acreage. Accordingly we publish below crop protection costs, on a basis of cost per pound of made tea using various methods of protection. Protection of 1,000 acres and a crop of 600 lbs. per acre are assumed. It will be noted that statement (g) assumes the recruitment of 190 extra labourers including wives, children, etc., a fact which is not considered in our costings as we do not agree that the recruitment of such extra labour, purely for crop protection work, is of general occurrence.

	Cost per lb. of made tea (Cents)
(*a*) "Whirlwind" dusting, using 4% Cuprosana dust at 4 lbs. per acre, every five days	13.8
(*b*) "Whirlwind" dusting, using 4% Cuprosana dust at 7 lbs. per acre, every ten days	12.7
(*c*) "Whirlwind" dusting, using 6% Cuprosana dust at 5¼ lbs. per acre, every ten days	10.0
(*d*) Hand dusting, using 4% Cuprosana dust at 4 lbs. per acre, every five days	13.0
(*e*) Hand dusting, using 4% Cuprosana dust at 8 lbs. per acre, every ten days	12.2
(*f*) Hand dusting, using 6% Cuprosana dust at 5¼ lbs. per acre, every ten days	9.5
(*g*) Knapsack spraying, using Cuprokylt at 6 ozs. per acre every ten days, using specially recruited labour	25.7
(*h*) As (*g*), with no extra labour cost involved	10.1

*The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.

QUESTIONS AND ANSWERS ON MANURIAL PROBLEMS

V. C. Baker & F. Haworth

The following questions by Mr. V. C. Baker, were put to the Director of the Institute before he addressed the Dickoya District Planters' Association on 25th July, 1952. A general request was made that the answers should be published in this Journal and they have been prepared for publication by Dr. Haworth.

Question 1—The T.R.I. recommendation for manure for seed bearers is in the proportion of nitrogen 61.6, phosphoric acid 32.5 and potash 60.0. As seed is only harvested and given off naturally, why the above proportion ? In tea in bearing where the bush is defoliated of its young leaf by pluckers (and blister blight) the proportion is usually given as nitrogen 51.5, phosphoric acid 32.4 and potash 37.6. Why is this ?

Answer—It must be admitted that the manure mixture advised for seed bearers is not based on direct experimental evidence. However, the recommendation of a fairly high level of manuring with a higher proportion of potash than is usual for tea in bearing is based on sound evidence which is as follows :—

(*a*) The ratio of potassium/nitrogen is higher in tea seed than in tea flush.

(*b*) The ratio of wood/leaf in seed bearers is higher than in tea in plucking and since the ratio of potassium to nitrogen is higher in wood than in leaf, (cf. Eden. Monographs on Tea Production in Ceylon No. 1, p. 27) an adequate amount of potash should be provided in the manure mixture.

(*c*) Tea seed bearers are not usually shaded and little is added to the soil by way of leaf-fall or green manure loppings.

(*d*) On many areas the fallen leaves are swept up and removed to facilitate the collection of the fallen tea seeds. This involves a considerable removal of nutrients from the soil which should be made up by the addition of extra manure.

Question 2—Field experiments by certain estates seem to favour much higher dosage of phosphoric acid and potash in proportion to nitrogen somewhat on the lines of the T.R.I. recommendation for seed bearers. I have heard of various arguments put forward of high nitrogen retention by the soils of Ceylon and the suggestion that with continued high application of nitrogen there is then not available the quantities of phosphoric acid and potash to give optimum results of the nitrogen unless more phosphoric acid and potash is made available.

Answer—The manure mixture recommended by the Tea Research Institute for use on mature tea is as follows :—

Sulphate of ammonia	320 lbs.
Saphosphosphate	105 lbs.
Muriate of potash 50%	75 lbs.

This mixture gives a ratio of nitrogen : phosphoric acid : potash of 8 : 3½ : 4½ approximately, and is commonly referred to as mixture T.R.I. 500.

There is an opinion current among some planters that this mixture is not " balanced " in that it contains too high a proportion of nitrogen. Beneficial results are claimed by these planters from an increase in the proportion of phosphoric acid and potash in the manure mixture. The response of the tea bush to fertilizer nutrients has been fully dealt with by Eden[1], and the experimental evidence obtained from the long term manurial experiments on St. Coombs estate forms the basis of the Institute's present manurial recommendations.

The amount of nutrients permanently removed from a tea field by 100 lbs. of made tea is given by Eden (*loc cit*) p. 27 as follows :—

	lbs.
Nitrogen	6.38
Phosphoric acid	1.55
Potash	3.47

It would, therefore, appear to be prudent to regard these amounts as the irreduceable minima which must be applied in the manure mixture to maintain the nutrient status of the soil.

The crop responses for the 6th cycle of the three factorial experiment started on St. Coombs in 1931 are summarised in Table 1.

These results show that for an 80 lb. dose of nitrogen the optimum dose of phosphoric acid would seem to be rather more than 30 lbs. per acre and the optimum dose of potash about 40 lbs. per acre which figures are well in accord with the ratio of 8 : $3\frac{1}{2}$: $4\frac{1}{2}$ for nitrogen : phosphoric acid : potash which the T.R.I. 500 mixture provides.

These results do not necessarily indicate any upper limit of application. Indeed from field practice on St. Coombs the response to nitrogen does not appear to fall off even at 120 lbs. nitrogen per acre (in presence of 47 lbs. phosphoric acid and 67 lbs. potash).

From another experiment laid down on St. Coombs there is further confirmation that 30 lbs. phosphoric acid and 40 lbs. potash are about adequate for 80 lbs. of nitrogen.

For the first three years of the experiment plots receiving 40 lbs. of nitrogen, 15 lbs. phosphoric acid and no potash gave only 5% less crop than plots receiving 40 lbs. of nitrogen, 30 pounds of phosphoric acid and 60 lbs. of potash. When the nitrogen was increased to 80 lbs. in the fourth year differential responses to the various doses of phosphoric acid and potash became apparent.

Hence it may be concluded that in the first three years of the experiment nitrogen was the limiting nutrient. The amount of phosphoric acid and potash were in excess of requirements.

From the evidence presented there appears to be no reason to suppose that a higher proportion of phosphoric acid and potash in the manure mixture would lead to more efficient utilization of the nitrogen in the mixture.

The further question as to the quantity of the recommended mixture which should be applied per acre is less easy to answer. On St. Coombs estate (rainfall 90") some 8 lb. nitrogen per 100 lbs. of made tea appears sufficient to maintain yields and also to allow the bushes to take advantage of favourable climatic conditions.

In other areas especially where rainfall is excessive (150" – 230") considerably higher amounts of manure ,up to 12 lbs. nitrogen per 100 lbs. made tea, have been found to be necessary to maintain yields. The reasons for the lowered utilization of added manure are not clear for factors other than climate are involved. The fact remains, however, that no rigid manuring programme can be laid down for tea in general, on the results of experiments carried out in one or two areas. The results can only form a basis and a guide on which the manuring programme for any particular estate can be based.

Table 1 *N. P. K. Experiment 6th Cycle.*
(*Lbs. per acre*).

N. applied in lbs.	Yield	Increment	Lbs. crop response per lb. N. applied
Nitrogen Treatment			
120	2012		
180	2221	209	3.5
240	2461	240	4.0
Phosphate Treatment			
P_2O_5 applied in lbs.			Per lb. P_2O_5 applied
0	2108		
90	2299	191	2.1
180	2287	–12	—
Potash Treatments			
K_2O applied in lbs.			Per lb. K_2O applied
0	1995		
60	2302	307	5.1
120	2397	95	1.6

MISCELLANEOUS NOTES

These notes are a new feature suggested by Mr. B. N. Webster and constitute the first of a proposed series intended for the publication of items of interest and importance, not necessarily of major importance, but which it is felt should be brought to a general notice. Some of these will probably form the basis of full length articles of a technical nature to be published elsewhere, but it is felt that certain facts should be made known as soon as is possible without a wealth of experimental details and data. It is not intended to be made a "gossip column", but suggestions for short notes on certain topics, possibly neglected ones, will be welcomed.

A NOTE ON PATHOLOGICAL MATTERS

B. N. Webster

Defoliation of seedlings of Albizzia species

There have recently been a number of reports, and examples, sent to us of almost complete defoliation of young Albizzia plants in the nursery. The plants examined have all been attacked by the fungus *Pleiochaeta albizziae* (Petch) Hughes, (formerly known as *Ceratophorum albizziae* Petch). This fungus produces its wind dispersed spores on yellow brown lesions, visible to the naked eye, on the infected leaflet. These spots eventually spread until the leaflet is shed. The ultimate picture is of "skeletons" of the plants left standing. The plants are sometimes killed, but even if they survive they suffer a severe set-back in development while the fungus is prevalent.

Control may be effected by weekly sprayings of the plants which should be under "pandals" with any of the common copper based fungicides at a concentration of 3 ounces in 5 gallons of water, until the plants are sufficiently large to be planted out. I am grateful to the number of superintendents who have confirmed that the above treatment is successful, following its suggested use.

Spraying of nurseries with copper fungicides

The practice of mulching nursery beds with fern, tea fluff, etc., to prevent excess of spray fluid entering the soil, as advised in the early days of blister blight spraying, is now thought to be unnecessary. This conclusion was drawn following the watering of one square yard of a nursery bed, containing approximately one hundred plants, with 1 gallon of Perenox at 4 ounces to 10 gallons, at fortnightly intervals for six months. Six months after the last treatment no adverse effects were noticeable and the plants have since been planted out and are flourishing. The amount of copper applied was greatly in excess of that applied over the same period and area by normal nursery spraying of 2 ounces of fungicide in 10 gallons of water every 4–5 days.

I am indebted to Mr. F. H. Kehl for the above details.

Lopping of low shade into the dry weather

There have been several instances of severe attacks of brown blight during the dry period of this year. In almost all the cases reported it was found that low-shade trees had been lopped into the dry period. Sudden removal of shade had resulted in

sun-scorch, and the brown blight fungus, which is not able actively to parasitise tea leaves, had entered the damaged tissues and, once in, had spread until whole leaves were destroyed. Where a long dry period is encountered it is not possible to avoid lopping at some time during its course, but the more gradually it is done, the better.

Fungicides

A number of complaints about proprietary fungicides have been received. We are not in a position to deal with such complaints, which should be addressed to the suppliers. Some however, have arisen through the use of incorrect measures, and we would emphasise again the need for the weighing out of each fungicide used in the first instance, and then the retention of a separate measure for each brand. These should be checked with each fresh drum used.

Insecticides and fungicides

One frequently hears both fungus diseases and insect pest damage being referred to as having been caused by a " puchi ". The literal translation being " insect ", it is not surprising therefore to find, on occasion, that an unknown diseased condition is treated with either an insecticide or fungicide. Provided both are used, then the desired effect might be achieved, but there is little to be gained by spraying any insects with copper fungicides, or many fungi with insecticides. Little damage is done in either instance unless the correct treatment is too long delayed, but the waste of material and time should be considered. Most of the common diseases are described in Dr. Gadd's monograph on " The Commoner Diseases of Tea ", and it is hoped that before long a similar one on insect pests will be available. Meanwhile, identifications can always be supplied by the Tea Research Institute. Spraying or dusting of mature tea with insecticides such as " Gammexane " which causes an undesirable taint, should not be undertaken without advice from this Institute.

A root disease of Acacias

Two cases of a root disease of Acacias and other plants, caused by the fungus *Irpex subvinosus* (B & Br.) Petch, have recently been found, one on *Acacia decurrens* growing in tea as a shade tree on a Dimbula estate, and the other on *Crotalaria agathifolia*, several plants of which had been allowed to grow up as seed bearers on St. Coombs. Mention is made of the occurrence of this disease as when it was last reported on Acacias in 1916 it was found to have infected adjacent tea by means of root contact. In the same publication it was stated to be a fairly common disease of Tephrosias, when these had been lopped over a number of years, and had also spread to tea from the infected Tephrosias.

The infected Acacia exhibited no visible signs of the fungus, the general appearance suggesting the effects of ring-barking, the leaves turned yellow-brown and hung down, remaining on the tree for some time. On uprooting the tree the bark was found to be cracked at the collar, and between the bark and the wood were sheets of yellowish white mycelium. This mycelium changed colour to lilac within twenty-four hours, and further lilac coloured mycelium was found to be growing on the undersides of all the lateral roots. In a few days time characteristic lilac coloured fructifications had developed over the greater part of the root surfaces. The spore bearing layer is distributed over numerous downward pointing teeth about 1/8″ in length, closely crowded together.

On the Crotalarias the infection had originated several feet from the ground, presumably by spore infection of the cut surfaces of lopped branches. The principle fructifications were borne on the undersides of the remaining stumps of these branches and around the collar at ground level. Tea bushes adjacent to both sites of infection were apparently healthy, but are being kept under observation. This practice should be adopted in the event of further cases of this disease being spotted.

A NOTE ON AN IMPROVEMENT TO PNEUMATIC KNAPSACK SPRAYERS

J. Landreth

Since the knapsack has evidently come to stay with us for some time, any improvement in its efficiency will have considerable cumulative effects. A steady pressure, and consequently a steady output, will obviously increase the area which can be covered by a single charge of spray liquid. The Engineering Department is investigating all the various possibilities for improving spraying equipment and a patent on the device described below has been applied for.

Considerable variation in the output of high pressure, low volume, nozzles takes place in the present pneumatic knapsack spraying equipment, due to reduction in air pressure as the liquid is discharged. The average output figures of the nozzles recommended by us can be taken as 5 gallons per hour at 60 lbs. per square inch pressure and 9 gallons per hour at 160 lbs. per square inch pressure. Whilst even distribution of fungicide is one of our aims, this is difficult to attain in view of the type of terrain on which tea is grown. We have, however, found that a pressure reducing valve fitted into the discharge outlet pipe of a knapsack sprayer and set at a predetermined pressure does ensure a constant output from the nozzles. This applies particularly to knapsacks which operate at the higher pressures, as the reducing valve can be adjusted to the initial air pressure in the container.

After carrying out some further tests, manufacturers will be approached regarding this modification.

A NOTE ON BORON DEFICIENCY OF BRASSICAE ON ST. COOMBS

F. Haworth

Many upcountry gardeners find that cauliflowers are difficult to grow. The commonest complaint is that the plants fail to produce heads, or produce small heads which turn brown and are inedible.

On St. Coombs, on a garden soil limed to pH value of about 6.0, typical boron deficiency symptoms have been observed on cauliflowers and brussels sprouts. In the case of cauliflowers, the chief symptom is the tardy production of small heads which display brown " waterlogged " patches. Another symptom is the vertical cracking of the stems and the rotting of the core. In the early stages of the disease the stem, when cut across, shows a brown discolouration.

In the case of brussels sprouts, the sprouts themselves are very loose instead of being hard and compact, and the same vertical cracking of the stem is found as with cauliflowers.

The application of 1 ounce of borax per 15 square yards of bed space allows healthy crops to be grown. The quantity of borax added must be accurately measured for an excess of borax is extremely harmful.

A NOTE ON MANURIAL MIXTURES

J. Lamb

Recent information suggests that a number of tea estates are still using mixture T. 420 for manuring tea in bearing.

This particular mixture was devised to meet the situation created by the shortage of supplies of fertilisers during the war when it was necessary to make the best use of available materials. Its use should have been discontinued immediately full supplies became available, especially as T. 420 is low in its potash content.

The standard mixture recommended by the Tea Research Institute for tea in bearing which may, for the sake of convenience, be called T.R.I. 500 is made up as follows :–

	Lbs.	N.	P_2O_5	K_2O
Ammonium Sulphate	320	65.92	—	—
Saphos Phosphate	105	—	30.97	—
Muriate of Potash 50%	75	—	—	37.5
	500	65.92	30.97	37.5

If muriate of potash 60% is employed instead of muriate of potash 50% according to availability of supplies and cost per unit of potash, the amount required will be 63 lbs. instead of 75 lbs. of 50% muriate of potash.

A small amount of conditioner is normally incorporated with fertiliser mixtures to prevent caking. The mixture and amount of conditioner can again be decided on availability and cost of materials.

FOREWORD

to

THE IMPORTANCE OF TEA FACTORY ORGANISATION

by

The Minister of Agriculture and Food

The Hon. Sir Oliver Goonetilleke, K.C.M.G., K.B.E.

The vital importance of the tea industry in the economy of Ceylon is well illustrated by the values of the domestic exports in the last two years.

	1950	1951
Tea	Rs. 752 million	Rs. 800 million
All other products	Rs. 743 million	Rs. 1,023 million

A decline in the prosperity of the tea industry must therefore have profound repercussions on the prosperity of the whole Island. The world's supply of tea has, during the past several years, fallen short of the demand for the beverage but in recent months the gap between supply and demand has been steadily closing and we are on the point of over-production.

Scarcity of a product not only compels the buyer to pay higher prices to the producer, but also to some extent to accept lower standards. The process reverses when over-production occurs. Ceylon can be justifiably proud of the fact that the standards of teas produced during the boom years did not fall to the same extent as they have done in other producing countries, and the reward for integrity is now being reaped in the form of competition for Ceylon teas in markets which are daily becoming more discriminating. We must now face the unpleasant reality of increasingly discriminating markets, and the future of the Island is clearly linked with our ability to maintain our lead in competition with other producers.

I understand that the Tea Research Institute has, in recent years, stressed the elementary fact that plants obtain the greater part of their food from the air in the form of carbon dioxide and that the tea plant, being no exception, obtains a greater part of its food through its leaves than through its roots. Success with both yield and quality therefore depends on leaving an equitable share of the leaf for the tea bush's own requirements and on the exercise of restraint in the amount taken for manufacture. Greed in harvesting not only results in lower standards of quality and appearance in the made tea, but also in debilitating the bush and lowering its capacity to produce.

I commend these facts to the serious attention of those who hope for quick profits.

It has been recently pointed out that the fundamental economic change taken place in the process generally known as " Ceylonisation of Estates " is a change from Company to private ownership and that Companies are primarily concerned

with preservation of capital values and the payment of regular dividends, whereas the private owner is too often concerned with quick profits. Quick profits are no longer possible on a discriminating tea market and the conservative management practised by Companies is to be strongly recommended to all owners not only in their own interests but in the interest of the country.

Although high quality tea depends very largely on high standards of leaf, the processing in the factory must preserve the quality and produce the types and grades required by the market. Haphazard manufacture cannot attain the standards demanded by a discriminating market if we wish to satisfy our customers and to induce them to buy our teas in preference to those of our competitors. Although there is undoubtedly skill needed in the manufacture of tea, I have no doubt that organising ability and attention to detail have more substantial rewards than any inspired genius. I recommend a close study of the methods for systematising manufacture described by Mr. Newton.

THE IMPORTANCE OF TEA FACTORY ORGANISATION

By

Gordon K. Newton

The *Tea Quarterly*, Vol. IX (1936), p. 199 contains an article on "Tea Factory Organisation and Management" by the writer, which was probably the first attempt in Ceylon to focus attention on the importance of methodical control in tea manufacture. This was followed up shortly afterwards by a paper on "Factory Organisation" delivered to the Tea Research Institute Conference in 1937 by F. J. Whitehead who did so much to systematise and control tea manufacture by reversible withering and by devising a system for organising rolling programmes. (Published in *Tea Quarterly*, Vol. X (1937), p.70.)

The outbreak of war in 1939 was followed by a period of ten years when tea was purchased under contract to the United Kingdom Government. It was inevitable that such a system should be introduced and that the lack of competition should remove the stimulation which kept teamakers interested in their jobs and estate managers actively concerned about the quality of leaf and standard of manufacture. When invoices sold on merit such a stimulus was a very real factor in maintaining high standards for our teas.

The Tea Research Institute realising the dangers inherent in a decline in standards of teas exported vigorously stressed the need for care in the control of plucking and organisation of manufacture. "A Review of Tea Manufacture in 1941" (*Tea Quarterly*, Vol. XIV (1941), p. 65) urged that more care should be taken in factory organisation and hygiene. At the Conference held in Kandy in 1949 the whole staff, aided by the late Mr. Robert Horne, delivered papers on various aspects of a common theme, namely the improvement of standards of plucking not only in the interests of the quality of teas exported, but also in maintaining the health and yield of the tea bush itself.

More recently, E. L. Keegel has published two important papers entitled "Common Problems in Tea Manufacture" (*Tea Quarterly*, Vol. XXII (1951), p. 20) reprints of which are still available, and "Relation of Coarse Plucking to Quality of Made Tea" (*Tea Quarterly*, Vol. XXII (1951) p. 112), both of which are fully up-to-date and worth close attention.

Fortunately, the standards of teas produced in Ceylon have not declined to the same extent as in other producing countries and we now have cause to be thankful for the efforts which have been made to maintain our reputation for quality.

With the re-opening of the Colombo Auctions in 1947, and subsequently the London Auctions in 1951, competition was re-introduced, but since a sellers' market remained, most types of tea found buyers willing to pay high prices until production commenced to overtake consumption in 1951. Now we have a buyers' market, and more tea being made in the world than is being drunk. Although we still see well made good quality teas selling at remunerative prices buyers are in a position to discount poorly made teas to a level below the cost of production. For those estates selling under cost of production there seems to be but two alternatives—

(1) To improve the quality of their output *or*

(2) To close down

Legislation relative to the employment of Estate labour has been introduced to stabilise the basic pay at an agreed minimum level, and since up to 60% of the cost of producing tea is on labour charges, any appreciable reduction in plantation production costs is not possible. The closure of estates means unemployment which

no one wishes to encourage. On the other hand, by improving manufacture, present full employment may be maintained and remunerative prices obtained for Principals.

I will now follow the outline of my article in 1936 and endeavour to formulate certain broad principles which must be adopted in tea manufacture if the best results are to be obtained. To make good tea it is essential to have leaf plucked regularly from well cultivated bushes ; the shorter the plucking rounds the better the leaf which may be taken, but in maintaining short rounds stripping must be avoided. The old planters' motto was " Leave one full leaf above the fish ", and there is nothing wrong with that dictum today. Assuming that all Agency controlled estates still follow this principle, it must be strongly commended especially to those who are outside such control. Suitable propaganda is necessary for smallholders, and every endeavour should be made to educate them up to a higher level of understanding on tea production, than is the case today. It must be remembered tea is Ceylon's largest national asset and any estate owner, however large or small, who neglects the fundamental requirements for making the best use of his property is not working in the fullest possible interest of the country.

Now to refer to specific control of tea factories. I wish to make it quite clear that the following suggestions do not necessarily indicate the best way to make tea—every estate has its particular requirements and peculiarities, of which those responsible are the best to judge—but it follows that by having some system of control, consistent results will be obtained.

In 1936 I wrote :—

" Following the leaf from the pluckers' hands we will assume that plucking is arranged so as to give an even flow of leaf to the factory, and that the leaf arrives at specified times by whatever method of transport is used.

It is most important that those responsible in the field should have definite written instructions as to when their leaf should be deliverd at the factory, and that these instructions be strictly carried out. The factory staff then knows when to expect leaf—with different seasons of the year times of weighing will probably vary, arrangements for which can easily be made.

The teamaker should know what amount of leaf he is to receive daily and the best time for estimation of leaf intake for the day is usually found to be at the morning muster, after the number of pluckers for work at each field has been ascertained. A note can then be made on the muster chit and the information transmitted to the factory."

This still applies.

The problem of smallholdings is complex but I feel that owners have plenty of scope to help themselves if they treat their tea well and pluck good leaf. Having done this, they may readily sell their leaf at good prices to factory owners who will thus have their profit assured. Exploitation about which smallholders complain today will be reduced by their own action. Smallholdings' advisory officers of the T.R.I. have been specially appointed to help this type of producer who can find a ready market for his leaf provided it is of good quality.

A Manager of a tea estate having taken steps to assure himself that suitable leaf will be delivered at his factory, will next be concerned over the method of manufacture to follow. No hard and fast rule can be laid down for all factories, as conditions differ so much, but however they may differ, the functioning of machines remains the same and daily intake to the factory has to be suitably fitted into thier capacity. In designing a programme one must first of all know the output of the driers at defined mechanical speeds, and from this knowledge one can calculate the amount of withered leaf to be fed to rollers over fixed intervals. Tea factories are usually equipped with machinery matched to the annual output of the estate, and for the purpose of illustration, let us take a factory having only one drier with an output of 200 lbs. made tea per hour.

Bearing in mind the broad principle that tea manufacture is based on a series of processes whereby the initial moisture content of green leaf is reduced from some 76% to 3% in the made tea, let us assume figures based on drier inlet temperatures of 180–200 degrees and a minimum of 120 degrees exhaust, and the fermented leaf having a moisture content of, say, 50 to 53 per cent. The difference in moisture of green leaf to fermented leaf (76% to 50%) has been effected in withering. Any variation in moisture content will affect the out-turn of the driers, hence the necessity (apart from other considerations) of being able to control a wither over a given period within the required limits. For this illustration we will assume that we are stripping from the tats leaf having a moisture content of 52 to 53 per cent.

If our made tea is to contain 3 per cent moisture we shall be driving off 49 per cent to 50 per cent moisture in the drying process, and in the rolling process a loss in weight of from 2 per cent to 3 per cent is usually registered.

Hence, for all practical purposes, to calculate the amount of withered leaf the driers are capable of dealing with, one must double the drier out-turn figures.

If one is withering harder or lighter than these figures allowance can be made either way.

Dealing with 200 lbs. made tea per hour and assuming that we commence the rolling programme with two rollers into each of which 250 lbs. withered leaf can be suitably charged, the charging interval is then easily calculated by converting the rate of firing into the rate of dealing with withered leaf.

200 lb. made tea per hour	=	400 lb. withered leaf per hour (or equivalent if wither is harder or softer)
400 lb. withered leaf per hour	=	$\frac{400}{60}$ lb. withered leaf per minute

A charge of 500 lb. of withered leaf will, therefore, feed the drier for

$$500 \times \frac{60}{400} = 75 \text{ minutes.}$$

The roller charging interval is therefore 75 minutes. By calculating the drier capacity in terms of withered leaf, the drier can be kept working without gaps in feeding over the day's work, and in the same way a complete table can be calculated for any factory equipped with one or a combination of driers showing how it is possible to keep them working uninterruptedly after work has commenced.

Provided a teamaker understands the set plan to be followed, he can take appropriate steps to see that withers are sufficiently controlled to provide leaf for feeding to the rollers to meet the predetermined programme. In many cases complications in adapting the capacity of rollers and roll breakers to drier output must arise, but a little ingenuity usually overcomes the problem. In practice it will be found necessary to lay down certain requirements for which the Head Teamaker will be responsible, in which connection I would like to stress the importance of the teamaker's work, which today is duly recognised by the majority of employers who remunerate in accordance with generous agreed scales, besides paying commission in many cases. For the future it is hoped this work will attract educated young men of a good social standing as it is interesting, well remunerated, work that should not be looked down upon by young men of good education. The Head Teamaker is of course responsible for carrying out the programme as set out by the Management, and he in turn delegates duties to junior members of the factory staff, such as the factory assistants, K.Ps, etc. To ensure that no misunderstandings take place and in order to maintain a high standard throughout daily working, it has been found advisable that written instructions should be given to those in charge of various departments in the factory.

The various units of machinery to which I have referred must always be maintained as specified by the makers. In particular the checking of speeds must be done at least once a week ; with such high variation in climatic conditions as we have in this country machinery driven by belting can vary in speed from day to day, and this must not be allowed to take place. The Superintendent will naturally want to be able to see quickly and easily what is happening when he pays calls of inspection at the factory. For some years now it has become common practice to have fixed, in conspicuous positions, various blackboards on which the teamaker sets out figures of green leaf estimates, leaf received, labour employed at the factory, as well as other details which may be required.

FIGURE I

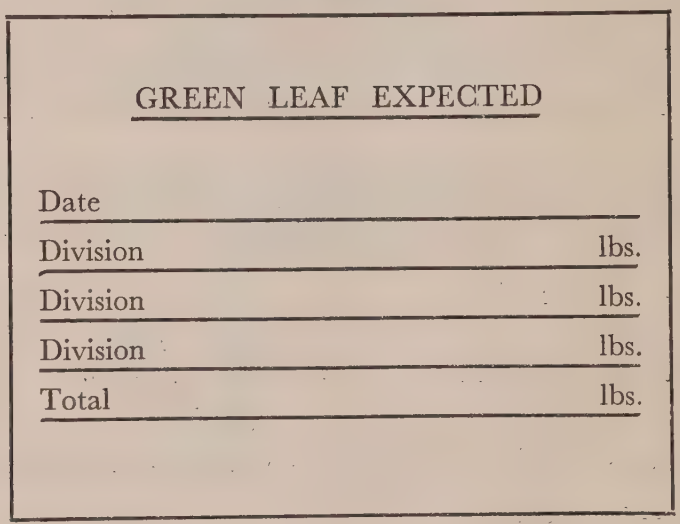
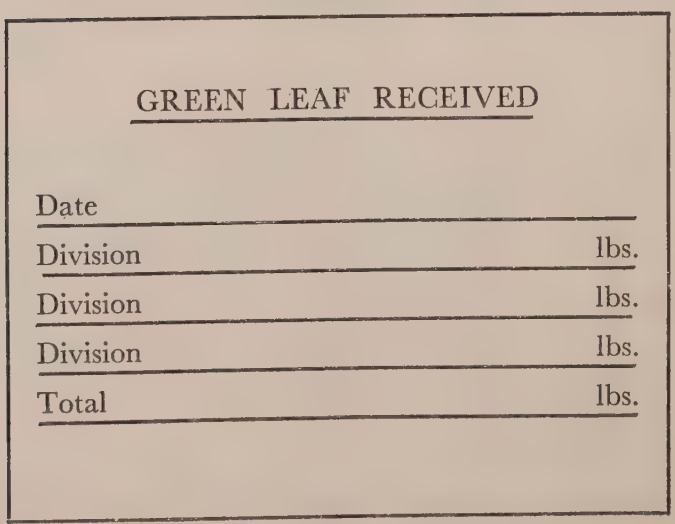


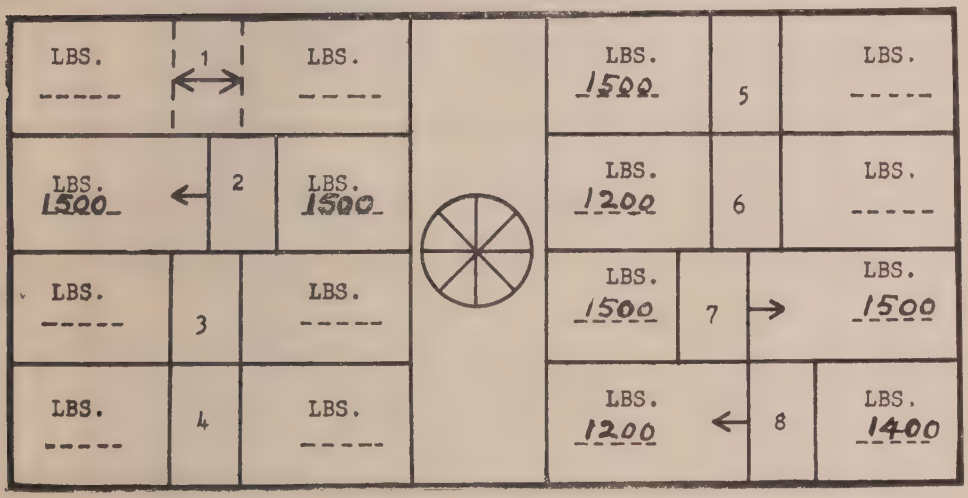
FIGURE II



Control of withering is usual rather than the exception now, various methods being used for which one of the factory assistants or K.Ps. is responsible. In order that control may be suitably elastic it is necessary to keep records showing the period and temperature of conditioned air used over various lofts with the degree of humidity. Apart from these figures it is useful to have an indicator which shows the Superintendent how withering is being carried out immediately he enters the factory, which saves much time and questioning.

FIG. III

WITHERING INDICATOR



1. Indicator is in the form of a Black Board on which lines and figures are set out in white paint.
2. Weights of green leaf may be chalked as spread daily.
3. Superimposed panels (as in loft No. 1 indicated by dotted lines) are fitted so as to slide to left or right to expose appropriate arrow indicating direction of air flow.
4. Loft 7 and 8 are shown in use with reversible air flow and loft 2 direct flow.

Records for withering, rolling and other processes are kept in a number of different ways, the actual detail being immaterial, provided the answers given are those required in checking and that forms are filled up with figures of *actual* results and not results which are *desired* by the Management.

The conscientious Superintendent will not only work out for his factory (probably in consultation with the V.A. and Engineers) the type of programme outlined, but will take the trouble to check weights and figures himself while manufacture is going on—preferably at times least expected by the factory staff.

FIGURE IV

WITHERING

Month:—

Date	Time received	No of Weighing	Factory Weight of Leaf	Condition and Type of Leaf	Spread in Lofts	TIME FANS WORKED			Time knocked down	Weight of withered Leaf	Period of wither	Weight of made tea	% Out-turn on withered Leaf	HYG. AT BULK. CHAMBER			
						On	Off	Period						Removal of Surface Moisture		Withering	
														Dry	Wet	Dry	Wet

FIGURE V

ROLLING

Weight of Green Leaf for day

Date:—

Time of Charging	Weight of withered leaf	ROLLERS											Mist Chamber	Weight of fermented leaf.	Loss in rolling.	Period of Fermentation.	Made tea weighed up.	Addapu dhool	HYGROMETRIC READINGS					
		1	2	3	4	5	6	7	8	9	10	11							Rolling room		Fermenting room		Outside	
																			Dry	Wet	Dry	Wet	Dry	Wet
Total																								
Per-centage																								

I do not propose to refer in detail to the final processes of grading and packing—sifting is a mechanical process following on tea firing in order that the bulk of fine and coarse leaf may be suitably graded to meet the requirements of the buyers. However I would like to emphasise that best results will be obtained by doing a maximum of sorting in the rolling room by roll breakers, instead of sifting fired tea causing " greying ".

Finally the sooner tea is packed after cooling off and sifting the less likelihood there is of moisture being absorbed and quality lost.

Colombo, 5th September 1952.

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NOTICES

The Institute's Laboratories and Offices are situated at St. Coombs, Talawakelle, and all applications and enquiries should be addressed to the Director, Tea Research Institute, St. Coombs, Talawakelle.

Specimens and other consignments sent by rail should be forwarded to Talawakelle Station c/o Messrs. M. Y. Hemachandra & Co., Forwarding Agents. *Carriage should be pre-paid.*

Visitors' Days. The *second* and *last* Wednesdays in each month have been set aside as Visitors' Days at St. Coombs Estate, and also at the T. R. I. Sub-Station, Gonakelle Estate, Passara, when it is hoped anyone interested will visit the Stations.

Rules for the Occupation of St. Coombs Guest House

(1) The Guest House is normally intended for the use of persons visiting the Institute and St. Coombs Estate on business. Children can in no circumstances be accommodated.

(2) Permission to occupy a room for the night must be obtained from the Director in writing and, unless sufficient notice be given, accommodation cannot be guaranteed.

(3) All visitors must sign the Visitors' Book on arrival.

(4) A bedroom may not be occupied for more than one night if required by another visitor. This shall not apply to Members of the Board or of Committees meeting at St. Coombs who shall also be entitled to priority in the allocation of accommodation when on official business.

(5) Complaints or suggestions shall be entered in the book provided for the purpose and not made to the Guest House Staff. All payments due for services rendered shall be made in *cash* to the Guest House Keeper and a receipt obtained from him on the official form. The scale of approved charges is posted in the building. The Guest House Keeper is forbidden to give credit or to accept cheques.

(6) All breakages will be charged for at cost price.